Evaluation Board for the AD7294 12-Bit, Multichannel, ADC, DACs, Temperature Sensors, and Current Sensors

EVAL-AD7294

FEATURES

Full featured evaluation board for AD7294
Graphical user interface software with USB control
Can be powered entirely from the USB port or using an external power source
Various link options

APPLICATIONS

Cellular base stations (GSM, EDGE, UMTS, CDMA)
Point-to-multipoint and other RF transmission systems
12 V, 24 V, 48 V automotive applications
Industrial control

GENERAL DESCRIPTION

This data sheet describes the evaluation board for the AD7294, which is a 12-bit monitoring and control device with multichannel ADC, DACs, temperature sensors, and current sensors. The AD7294 is a highly integrated solution that offers all the functionality necessary for precise control of the power amplifier in cellular base station applications.

The AD7294 includes low voltage (±200 mV) analog input sense amplifiers for current monitoring across shunt resistors, temperature sense inputs, and four uncommitted analog input channels multiplexed into a successive approximation (SAR) analog-to-digital converter (ADC) with a 3 µs conversion time. A high accuracy internal reference is provided to drive both the digital-to-analog converter (DAC) and the ADC. Four 12-bit DACs provide the outputs for voltage control. The AD7294 also includes limit registers for alarm functions.

The part is designed on the Analog Devices, Inc., high voltage diffused metal-oxide semiconductor (DMOS) process for high voltage compliance—59.4 V on the current sense inputs, and up to a 15 V for the DAC output voltage. Full details about the AD7294 are available in the AD7294 data sheet, which is available from Analog Devices and should be consulted in conjunction with this data sheet when using this evaluation board.

Configuration of the various link options is explained in the Evaluation Board Hardware section. Interfacing to the AD7294 is through a USB microcontroller, which generates the I²C signals. External sockets are provided for several input and output signals. The EVAL-AD7294 is supplied with software to enable communication between the user and the device. Other on-board components include an EEPROM, a Cypress USB microcontroller, and a voltage regulator.

FUNCTIONAL BLOCK DIAGRAM

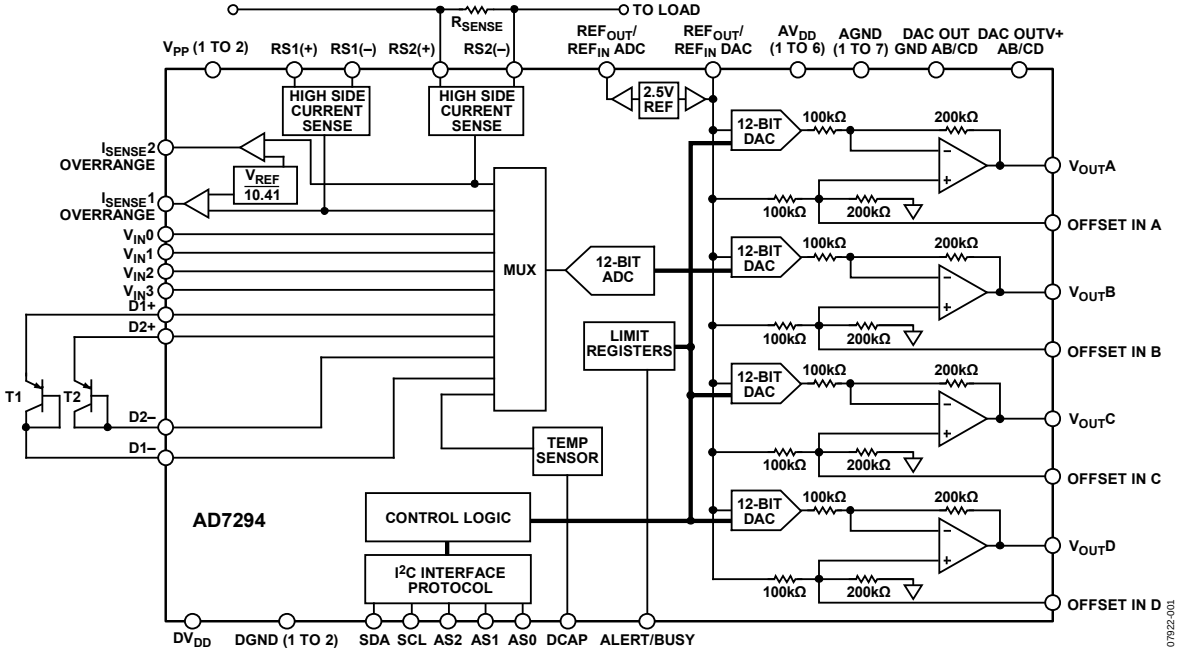

Figure 1. Typical Configuration for AD7294 in Cellular Base Station RF Lateral-Diffused Metal-Oxide Semiconductor (LDMOS) Power Amplifier Control

Rev. 0

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 **www.analog.com**
Fax: 781.461.3113

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REVISION HISTORY

4/09—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

There are two options available for powering the AD7294 evaluation board:

- Using the USB port of a computer
- Using an external power supply

The default option for powering the board is to use the USB port. This option is selected when K12, K13, and K14 are in Position A; however, in addition, K10 must be connected to DV_{DD} and $AV_{DD}x$, and K11 must be connected to $AV_{DD}x$ and DAC OUTV+ xx. The 5 V from the USB port is regulated to 3.3 V, which provides power for the USB controller and related USB circuitry. The USB port also provides the ground connections for the board.

Alternatively, the other option for powering the board is to use terminal blocks to enable the use of an external power supply. This option is selected when K12, K13, and K14 are in Position B; K10 and K11 can be, but do not have to be, inserted as previously described.

Extensive ground planes are used on this board to minimize the effect of high frequency noise interference. There are two ground planes: the AGND plane and the DGND plane. These planes are connected at one location close to the AD7294; therefore, it is not recommended to connect the AGND and DGND planes elsewhere in the system. The AVDD and DVDD planes are decoupled to the relevant ground plane using 10 μF and 0.1 μF ceramic capacitors connected to the AD7294.

The AD7294 device requires three power supply inputs: the AV_{DD}, DV_{DD}, and V_{DRIVE}. The analog and digital supplies are independent of each other. The AV_{DD} and DV_{DD} supplies should be to tied to the same supply and can be powered from 4.5 V to 5.5 V. The V_{DRIVE} supply can be power from 2.7 V to 5.5 V and can be different from the supply on AV_{DD} and DV_{DD}. The evaluation board also contains an independent analog power supply for the operational amplifiers.

LINKS

The link options on the evaluation board should be set for the required functionality prior to using the board. There are 20 link options, the functions of which are outlined in Table 1. By default, power to the board is supplied through the USB port.

Table 1. Link Function Descriptions

Link No.	Function
K1	This link option selects the source of the $V_{IN}0$ analog input to the AD7294.
	K1 inserted: the $V_{IN}0$ analog input is tied directly to AGNDx.
	K1 removed: the $V_{IN}0$ analog input must be supplied by an external source via the $V_{IN}0$ SMB socket.
K2	This link option selects the source of the $V_{IN}1$ analog input to the AD7294.
	K2 inserted: the $V_{IN}1$ analog input is tied directly to AGNDx.
	K2 removed: the $V_{IN}1$ analog input must be supplied by an external source via the $V_{IN}1$ SMB socket.
K3	This link option selects the source of the $V_{IN}2$ analog input to the AD7294.
	K3 inserted: the $V_{IN}2$ analog input is tied directly to AGNDx.
	K3 removed: the $V_{IN}2$ analog input must be supplied by an external source via the $V_{IN}2$ SMB socket.
K4	This link option selects the source of the $V_{IN}3$ analog input to the AD7294.
	K4 inserted: the $V_{IN}3$ analog input is tied directly to AGNDx.
	K4 removed: the $V_{IN}3$ analog input must be supplied by an external source via the $V_{IN}3$ SMB socket.
K5	This link option selects the source of the D1− current sensor input signal to the AD7294.
	K5 in Position A: the D1− current sensor input signal is supplied by an external source via the D1− SMB socket.
	K5 in Position B: the D1− current sensor input signal is tied directly to the D1+ signal and is therefore supplied by the D1+ SMB socket.
K6	This link option selects the source of the D2− current sensor input signal to the AD7294.
	K6 in Position A: the D2− current sensor input signal is supplied by an external source via the D2− SMB socket.
	K6 in Position B: the D2− current sensor input signal is tied directly to the D2+ signal and is therefore supplied by the D2+ SMB socket.
K7	This link option selects the source of the AS0 logic signal for addressing the device.
	K7 inserted: the AS0 input is connected to DGND, a logic low signal.
	K7 removed: the AS0 input is connected directly to V_{DRIVE}, a logic high signal.
K8	This link option selects the source of the AS1 logic signal for addressing the device.
	K8 inserted: the AS1 input is connected to DGND, a logic low signal.
	K8 removed: the AS1 input is connected directly to V_{DRIVE}, a logic high signal.
K9	This link option selects the source of the AS2 logic signal for addressing the device.
	K9 inserted: the AS2 input is connected to DGND, a logic low signal.
	K9 removed: the AS2 input is connected directly to V_{DRIVE}, a logic high signal.
K10	This link option connects the DV_{DD} supply to the $AV_{DD}x$ supplies.
	K10 inserted: the DV_{DD} supply is connected to the $AV_{DD}x$ supplies.
	K10 removed: the DV_{DD} supply is not connected to the $AV_{DD}x$ supplies.
K11	This link option connects the DAC OUTV+ AB and DAC OUTV+ CD supplies to the $AV_{DD}x$ supplies.
	K11 inserted: the DAC OUTV+ AB and DAC OUTV+ CD supplies are connected to the $AV_{DD}x$ supplies.
	K11 removed: the DAC OUTV+ AB and DAC OUTV+ CD supplies are not connected to the $AV_{DD}x$ supplies.
K12	This link option selects the source of the DV_{DD} power supply.
	K12 in Position A: the DV_{DD} digital supply for the AD7294 is supplied by a 5 V supply from the USB port.
	K12 in Position B: the DV_{DD} digital supply for the AD7294 must be supplied by an external source via the J3-1 connector.
K13	This link option selects the source of the $AV_{DD}x$ power supplies.
	K13 in Position A: the $AV_{DD}x$ analog supplies for the AD7294 are supplied by a 5 V supply from the USB port.
	K13 in Position B: the $AV_{DD}x$ analog supplies for the AD7294 must be supplied by an external source via the J3-5 connector.
K14	This link option selects the source of the DAC OUTV+ xx power supplies.
	K14 in Position A: the DAC OUTV+ AB and DAC OUTV+ CD supplies for the AD7294 are supplied by a 5 V supply from the USB port.
	K14 in Position B: the DAC OUTV+ AB and DAC OUTV+ CD supplies for the AD7294 must be supplied by an external source via the J3-3 connector.

Link No.	Function
K15	This link option selects whether the V_{OUT} A signal is filtered prior to being supplied to the V_{OUT} A SMB.
	K15 in Position A: the V_{OUT} A signal is filtered by a 100 kΩ resistor and a capacitor. This link option should be used in conjunction with K16 in Position A to provide the output signal to the V_{OUT} A SMB.
	K15 in Position B: the V_{OUT} A signal from the AD7294 is connected directly to K16. This link option should be used in conjunction with K16 in Position B to provide the output signal to the V_{OUT} A SMB.
K16	This link option connects the V_{OUT} A signal to the V_{OUT} A SMB. This link should be used in conjunction with K15.
	K16 in Position A: the V_{OUT} A signal is filtered by a 100 kΩ resistor and a capacitor. This link option should be used in conjunction with K15 in Position A to provide the output signal to the V_{OUT} A SMB.
	K16 in Position B: the V_{OUT} A signal is connected directly from the AD7294 to the V_{OUT} A SMB. This link option should be used in conjunction with K15 in Position B to provide the output signal directly to the V_{OUT} A SMB.
K17	This link option selects whether the V_{OUT} B signal is filtered prior to being supplied to the V_{OUT} B SMB.
	K17 in Position A: the V_{OUT} B signal is filtered by a 100 kΩ resistor and a capacitor. This link option should be used in conjunction with K18 in Position A to provide the output signal to the V_{OUT} B SMB.
	K17 in Position B: the V_{OUT} B signal is connected directly to K18. This link option should be used in conjunction with K18 in Position B to provide the output signal to the V_{OUT} B SMB.
K18	This link option connects the V_{OUT} B signal to the V_{OUT} B SMB. This link should be used in conjunction with K17.
	K18 in Position A: the V_{OUT} B signal is filtered by a 100 kΩ resistor and a capacitor. This link option should be used in conjunction with K17 in Position A to provide the output signal to the V_{OUT} B SMB.
	K18 in Position B: the V_{OUT} B signal is connected directly from the AD7294 to the V_{OUT} B SMB. This link option should be used in conjunction with K17 in Position B to provide the output signal directly to the V_{OUT} B SMB.
K19	This link option selects the source of the DAC HIGH-Z pin.
	K19 in Position A: the DAC HIGH-Z pin is connected directly to the V_{DRIVE} supply.
	K19 in Position B: the DAC HIGH-Z pin is connected directly to the AGNDx supplies.
K22	This link option selects the source of the V_{DRIVE} supply.
	K22 in Position A: the V_{DRIVE} supply of the AD7294 is tied directly to the DV_{DD} supply.
	K22 in Position B: the V_{DRIVE} supply of the AD7294 is tied directly to the 3.3 V supply.

Table 2. Link Positions When EVAL-AD7294 Is Packaged

Link No.	Position	Description
K1	Removed	The analog input signal of the AD7294 is connected directly to the $V_{IN}0$ SMB.
K2	Removed	The analog input signal of the AD7294 is connected directly to the $V_{IN}1$ SMB.
K3	Removed	The analog input signal of the AD7294 is connected directly to the $V_{IN}2$ SMB.
K4	Removed	The analog input signal of the AD7294 is connected directly to the $V_{IN}3$ SMB.
K5	A	The D1− current sensor input signal is supplied by an external source via the D1− SMB socket.
K6	A	The D2− current sensor input signal is supplied by an external source via the D2− SMB socket.
K7	Inserted	The AS0 input is connected to DGND, a logic low signal.
K8	Inserted	The AS1 input is connected to DGND, a logic low signal.
K9	Inserted	The AS2 input is connected to DGND, a logic low signal.
K10	Removed	The DV_{DD} supply is not connected to the AV_{DD}x supplies.
K11	Removed	The DAC OUTV+ AB and DAC OUTV+ CD supplies are not connected to the AV_{DD}x supplies.
K12	A	The DV_{DD} digital supply for the AD7294 is supplied by a 5 V supply from the USB port.
K13	A	The AV_{DD}x analog supplies for the AD7294 are supplied by a 5 V supply from the USB port.
K14	A	The DAC OUTV+ AB and DAC OUTV+ CD supplies for the AD7294 are supplied by a 5 V supply from the USB port.
K15	B	The V_{OUT} A signal is connected directly to K16.
K16	B	The V_{OUT} A signal is connected directly from the AD7294 to the V_{OUT} A SMB.
K17	B	The V_{OUT} B signal is connected directly to K18.
K18	B	The V_{OUT} B signal is connected directly from the AD7294 to the V_{OUT} B SMB.
K19	B	The DAC HIGH-Z pin is connected directly to AGNDx supplies.
K22	A	The V_{DRIVE} supply of the AD7294 is tied directly to the DV_{DD} supply.

SOCKETS

There are 22 SMB input/output sockets relevant to the operation of the AD7294 on this evaluation board. All of these sockets are used for applying an externally generated signal to the evaluation board or for accessing an output signal from the AD7294. When operating the board with the USB power source, the only external sockets necessary are those used to supply the input signals to the analog inputs of the ADC (that is, $V_{IN}0$, $V_{IN}1$, $V_{IN}2$, and $V_{IN}3$), the current sensor input signals (that is, RS1(+) and RS2(+)), and the temperature sensor input signals (that is, D1+, D1−, D2+, and D2−).

The DAC outputs can be accessed via the V_{OUT} A, V_{OUT} B, V_{OUT} C, and V_{OUT} D SMBs, and the current senor overrange outputs can be accessed via the $I_{SENSE}1$ and $I_{SENSE}2$ SMBs. The functions of all the SMB sockets on the AD7294 evaluation board are outlined in Table 3.

Table 3. Socket Functions

Socket	Function
RS1(+), RS2(+)	Subminiature bayonet nut connector (BNC) sockets for the input signals that are applied directly to the RS2(+)
$V_{IN}0$, $V_{IN}1$, $V_{IN}2$, $V_{IN}3$	Subminiature BNC sockets for the analog input signals that are applied directly to the $V_{IN}0$, $V_{IN}1$, $V_{IN}2$, and $V_{IN}3$ pins, respectively
D1+, D2+	Subminiature BNC sockets for the input signals that are applied directly to the D1+, and D2+ pins, respectively
D1−, D2−	Subminiature BNC sockets for the input signals that are applied directly to the D1−, and D2− pins, respectively
$I_{SENSE}1$, $I_{SENSE}2$	Subminiature BNC sockets for the $I_{SENSE}x$ output signals that are generated by the AD7294
V_{OUT} A, V_{OUT} B, V_{OUT} C, V_{OUT} D	Subminiature BNC sockets for the V_{OUT} x output signals that are generated by the AD7294
OFFSET IN A, OFFSET IN B, OFFSET IN C, OFFSET IN D	Subminiature BNC sockets for the OFFSET IN x input signals that are applied to the AD7294
REF_{IN} DAC	Subminiature BNC sockets that enable an external reference source to be supplied to the DACs on the AD7294
REF_{IN} ADC	Subminiature BNC sockets that enable an external reference source to be supplied to the ADC on the AD7294

CONNECTORS

There are two connectors (J2 and J3) on the EVAL-AD7294, as outlined in Table 4.

Table 4. Connector Functions

Connector	Function
J2-1	External RS2(+) power connector
J2-2	External RS1(+) power connector
J3-1	External DV_{DD} power connector
J3-2	DGND power connector
J3-3	External DAC OUTV+ AB and DAC OUTV+ CD power connector
J3-4	AGNDx power connector
J3-5	External $AV_{DD}x$ power connector
J3-6	AGNDx power connector

GETTING STARTED

SUMMARY OF THE SETUP SEQUENCE

This installation was carried out using the Windows XP® operating system. The installation consists of the following steps, which are described in detail in the sections that follow.

1. Install the AD7294 graphical user interface software, which accompanies the evaluation board. Do not connect the USB cable from the AD7294 evaluation board to the computer USB hub at this stage. See the Installing the Software section for more information.
2. Connect the USB port from the computer to the evaluation board, and run the USB installation wizard. See the Connecting the USB Cable section for more information.
3. Ensure that the appropriate links are made throughout the evaluation board, and then power up the evaluation board. See the Verifying the Links and Powering Up the Evaluation Board section for more information.
4. Use the evaluation board software to operate the various functions on the part.

INSTALLING THE SOFTWARE

1. Place the evaluation board software installation CD into the CD drive of your computer and open **My Computer**.
2. Double-click the **Disc Drive** icon.
3. In the **AD7294 Installation** folder, double-click **Setup.exe** (see Figure 2) and install the software on the hard drive of your computer by using the installation wizard (see Figure 3). It is recommended to install the software in the default destination folder path, **C:\Program Files\Analog Devices Inc\AD7294**.

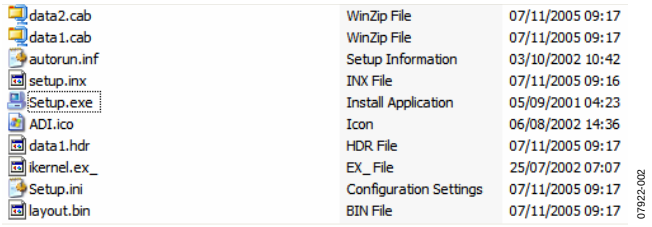

Figure 2. Select Setup.exe

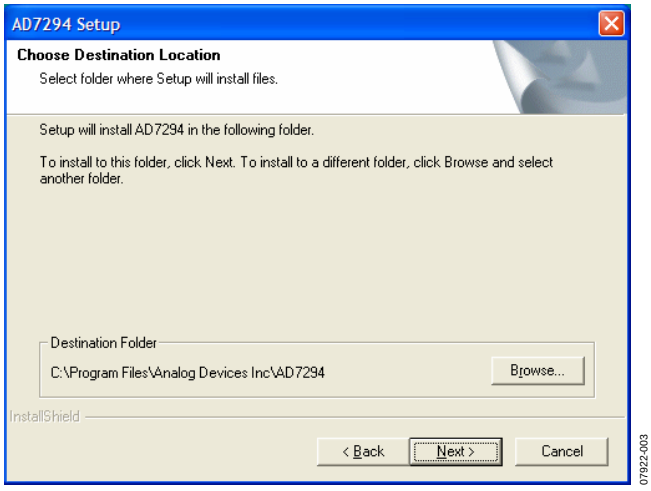

Figure 3. AD7294 Setup, Choose Destination Location Window

4. Choose **Analog Devices** from the **Select Program Folder** window (see Figure 4). If the Analog Devices folder does not yet exist, create a folder called Analog Devices and add the program icon to this new folder (see Figure 5).

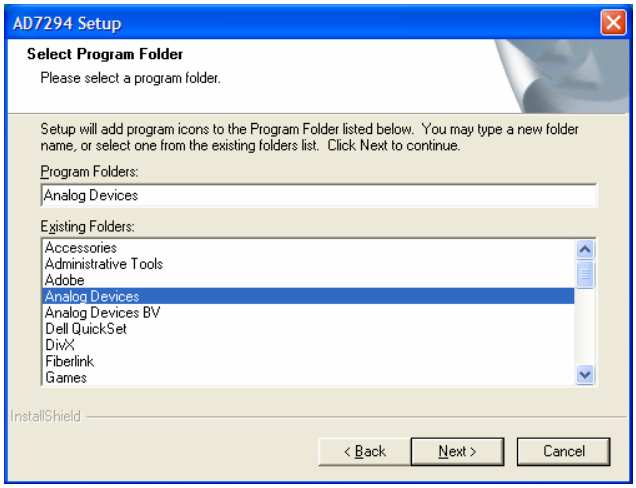

Figure 4. AD7294 Setup, Select Program Folder Window

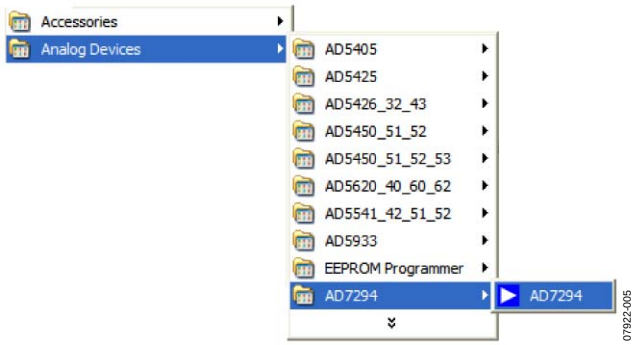

Figure 5. Add the Program Icon

5. After installing the software, remove the CD from the disc drive.

6. The message shown in Figure 6 will appear because the firmware code, which is downloaded to the evaluation board EEPROM memory each time the interface software program is opened, has not yet been downloaded. The firmware code cannot be downloaded yet because there is no USB connection between the computer and the AD7294 evaluation board at this stage; therefore, this error message is to be expected.
7. Click **Cancel** and proceed to the procedures in the Connecting the USB Cable section.

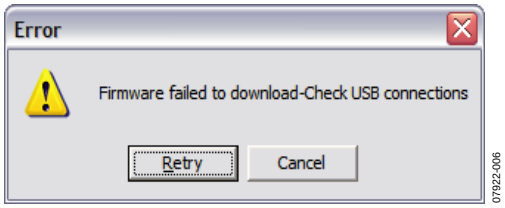

Figure 6. Expected Error Message

CONNECTING THE USB CABLE

1. Plug the USB cable into the computer USB hub and into the AD7294 evaluation board.
2. A message tells you that a USB device has been detected and that new hardware has been found (see Figure 7).

Figure 7. Found New Hardware Message

3. The **Found New Hardware Wizard** window appears (see Figure 8). This wizard installs software for the AD7294 evaluation kit.
4. Select **Install the software automatically (Recommended)** (see Figure 8), and then click **Next** to continue.

Figure 8. Found New Hardware Wizard

5. A warning message appears (see Figure 9), indicating that the new hardware you are installing (AD7294 evaluation kit) has not passed the Windows logo testing to verify compatibility with Windows XP. This error appears because this is an evaluation setup installation and is not meant to be used in a production environment.
6. Click **Continue Anyway**, and then click **Finish**.

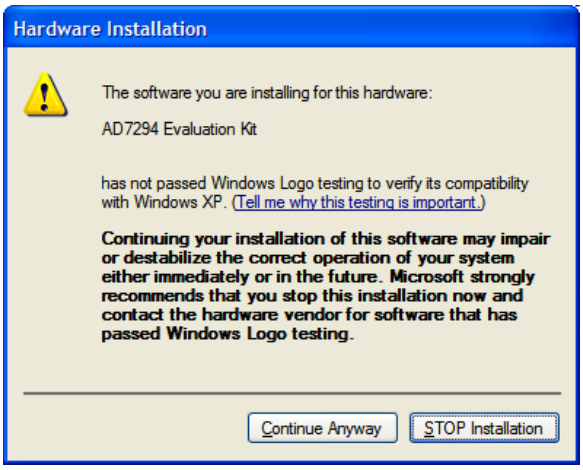

Figure 9. Expected Warning Message

7. The **Found New Hardware** message appears, alerting you that your new hardware is installed and ready to use (see Figure 10).

Figure 10. New Hardware Is Ready to Use Message

To learn more about verifying and troubleshooting this installation, refer to the Frequently Asked Questions section.

VERIFYING THE LINKS AND POWERING UP THE EVALUATION BOARD

Care should be taken before applying power and signals to the evaluation board. It is necessary to ensure that all links are positioned correctly for the chosen operating mode. Table 2 shows the position in which all the links are set when the evaluation board is packaged. There are two different modes in which to operate the evaluation board. The user can either operate the board with an external supply or use the supply provided by the USB port. When the board is shipped, it is assumed that the user will be operating with the power provided by the USB port.

When using the power supply from the USB port,

1. Ensure that all links are positioned correctly for the chosen operating mode. It is important to note that the USB connector cannot act as a supply source to the AD7294 if the K10, K11, K12, K13, and K14 links are not inserted.
2. Connect the USB cable to your PC and to the evaluation board. Power is supplied automatically to the AD7294 after the links are correctly positioned as outlined.

When using an external power supply,

1. Ensure that all links are positioned correctly for the chosen operating mode.
2. Ensure that all relevant external power connections are made before using the software for the device. You can supply these signals from an external supply via the power supply connectors (J3) on the board or use the on-board ADP3303 precision voltage reference.
3. Plug in the USB cable. If you do not wish to use the software provided and all external supplies are used, this cable is not required.
4. Turn on the external power supply.

After powering up the evaluation board, you can start using the software to evaluate the board. Note that the board must be repowered when the software window is closed; that is, the USB must be disconnected and reinserted.

EVALUATING THE BOARD

The evaluation board software allows the user to load values to the four DACs in the AD7294, read values from the 9-channel multiplexed ADC and then depict these values in a plot, monitor a signal between two limited values, and change the configuration of the device. See the Using the Software section for more detailed information about these functions.

USING THE SOFTWARE

MAIN WINDOW

After following the procedures in the Getting Started section, the main window, shown in Figure 11, appears upon starting the evaluation software program. Use the drop-down menus in this window to navigate through the various operational functions of the AD7294 evaluation board.

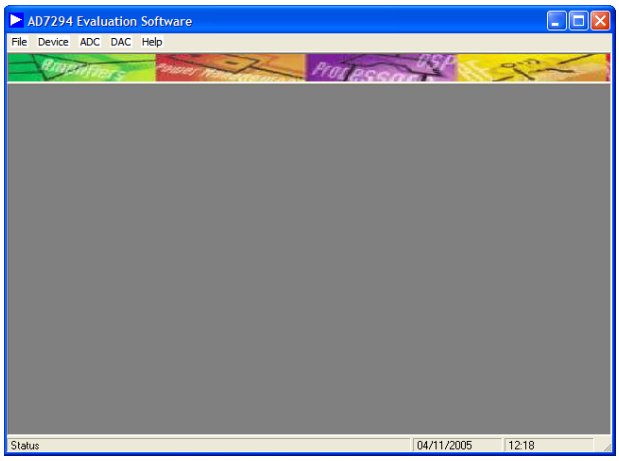

Figure 11. AD7294 Evaluation Software, Main Window

Device Menu

The **Device** menu (see Figure 12) offers three options: **Configuration**, **Register Map**, and **Device Address**. Select **Configuration** to change the configuration address, which can be used to select various modes and configurations of the device. Each of these options is examined in more detail in the Configuration Window section. Selecting **Register Map** provides a user-friendly tool to easily check the value of each bit in every readable register address, and selecting **Device Address** allows you to choose the I^2C slave address upon power-up.

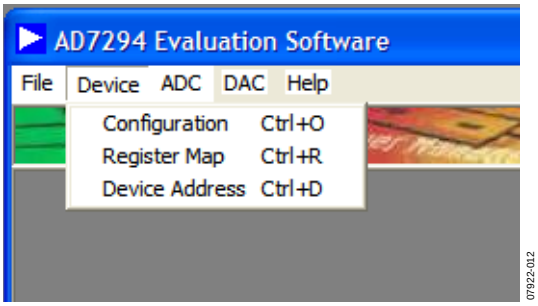

Figure 12. Device Menu of the Main Window

ADC Menu

As shown in Figure 13, the **ADC** menu can be used to access three functions: **Read Channel**, **Alert Manager**, and **External Sensor Calibration**. Selecting **Read Channel** shows most of the functionality options of the ADC. As suggested by the names of the other two menu options, the **Alert Manager** window analyzes the alert register to check for out-of-limit alerts, whereas selecting **External Sense Calibration** enables calibrating the external temperature sensors.

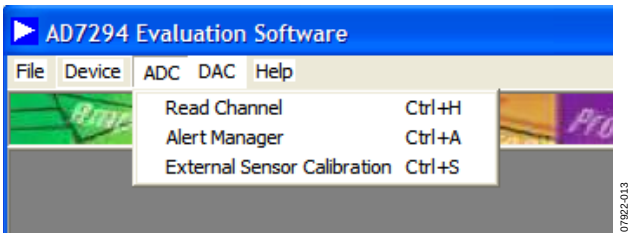

Figure 13. ADC Menu of the Main Window

DAC Menu

The **DAC** menu allows you to load values to any of the four DAC channels.

CONFIGURATION WINDOW

The configuration of the various modes and functionalities of the device is carried out in the **Configuration** window. Two tabs are available in this window. The first tab, **Power Down**, offers various power-down mode options. Click the appropriate check box to select the desired option (see Figure 14), and then the equivalent bit is automatically set in the configuration register in the device (this can be checked using the register map).

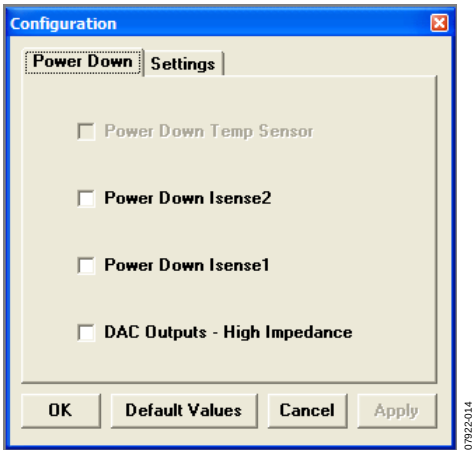

Figure 14. Power-Down Modes Available in the Configuration Window

The second tab, **Settings**, allows the selection of various operating modes available for the AD7294 (see Figure 15).

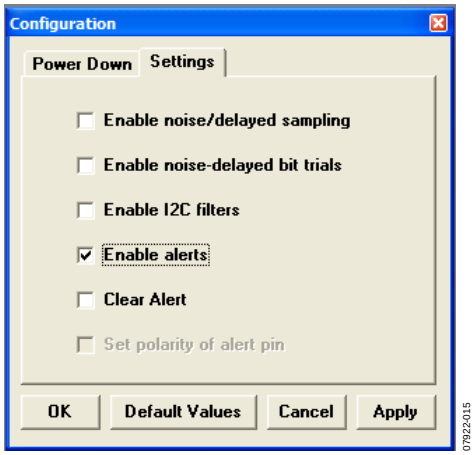

Figure 15. Modes Available in the Settings Tab of the Configuration Window

REGISTER MAP WINDOW

The **Register Map** window is a useful tool that allows reading any register that can be accessed by the address pointer register. For more information, see the AD7294 data sheet. Each data register, whether 8 bits or 16 bits, is accessed by the software, and then the contents are displayed in this window. The window provides details about the function or mode represented by each bit, as shown in Figure 16. The **Register Details** box of this window allows the user to see the decimal value of a register and its position in the address pointer register.

DEVICE ADDRESS INFORMATION WINDOW

The serial bus address byte is the first byte that the user writes to the device. The five LSBs of this byte are user programmable on the evaluation board, with the I^2C address determined by the logic state of the AS1, AS2, and AS3 pins (that is, by connecting jumpers to the AS1, AS2, and AS3 pins). For more information, see the AD7294 data sheet. With a jumper inserted, the signal is grounded; therefore, K7 reads 0 with a jumper inserted (see Figure 17).

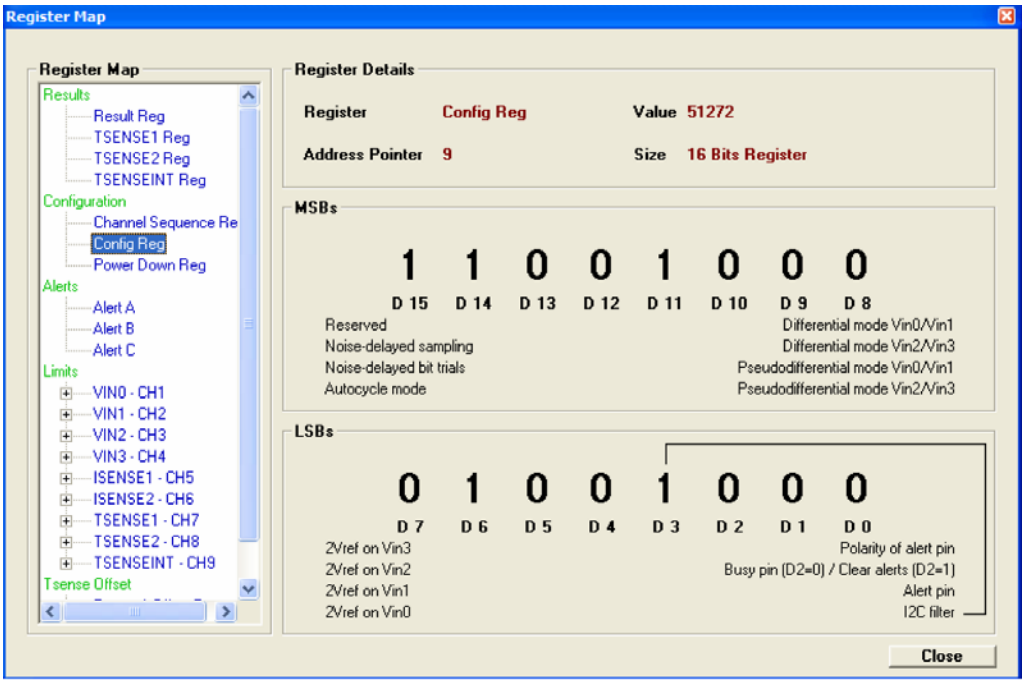

Figure 16. Register Map Window

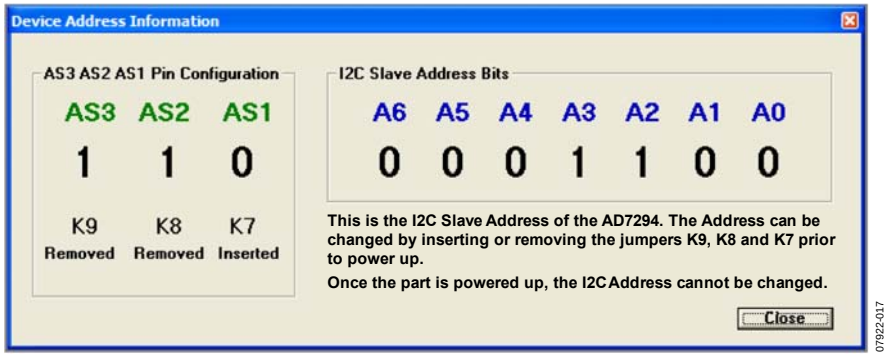

Figure 17. Device Address Information Window

READ CHANNEL WINDOW

To read the converted analog signals from the 9-channel ADC, select **Read Channel** in the **ADC** menu of the main window. The **Read Channel** window appears, allowing you to select which channel to access by clicking one of the nine tabs at the top of the window. There are two methods of reading the converted data. Clicking **Read Single Value** adds one value at a time to a list, whereas clicking **Start Scope** results in the values being stored in an array to draw the scope plot. Various user options are also available in this window (see Figure 18).

The differential mode can be selected for Channel 1 to Channel 4 ($V_{IN}0$ to $V_{IN}3$). This mode allows analog input signals on Channel 1 and Channel 2 to become a differential input pair and input signals on Channel 3 and Channel 4 to form another differential pair. In addition, in differential mode it is possible to use the input channels in pseudo-differential mode when an offset from ground is provided on one of the differential inputs, thus enabling the advantage of canceling common-mode voltages.

To zoom in on a signal in the plot, use the arrows in the corners of the graphing tool (circled in blue in Figure 18). To activate the $DATA_{HIGH}$ and $DATA_{LOW}$ functions and the hysteresis functions, click the arrow in the top left of the window (circled in red in Figure 18). Two tab options appear on the right side of the window: the **Limits** tab and the **Vref** tab. With the **Limits** tab selected, you can set up predetermined limits for the converted input signals. The alert bit is flagged and the relative bit in the alert status register is triggered when the input signal becomes greater than the $DATA_{HIGH}$ limit or less than the $DATA_{LOW}$ limit. Note that the alert bit does not turn off until the signal is within the specified hysteresis limits (see the circled signal in Figure 19). To benefit from this option, you must click **Alert Manager** at the lower right of the window or select the **Alert Manager** from the **ADC** menu in the main window of the evaluation software.

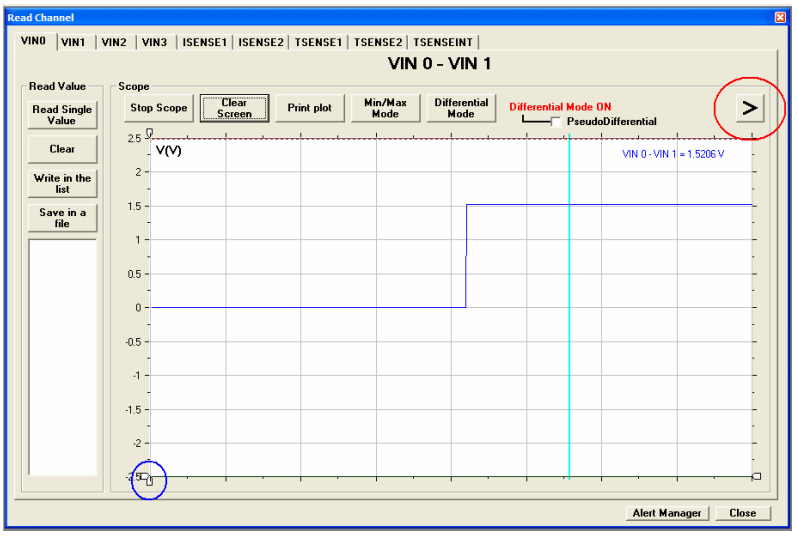

Figure 18. Read Channel Window

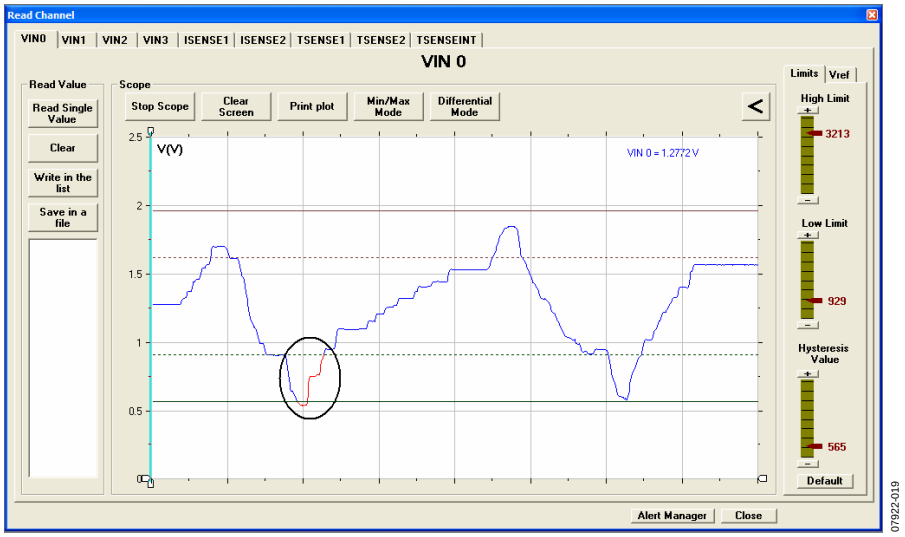

Figure 19. Data Limit Function

If the hysteresis register is filled with all 1s, the part operates in minimum/maximum mode. The $DATA_{HIGH}$ register stores the maximum conversion result, and the $DATA_{LOW}$ register stores the minimum conversion result. The minimum/maximum mode is enabled by clicking **Min/Max Mode** or by dragging the limit up to 4095 in the **Hysteresis Value** box in the **Limits** tab (see Figure 19).

The **Vref** tab (see Figure 21) allows you to select an external reference for the ADC, with two decimals of accuracy.

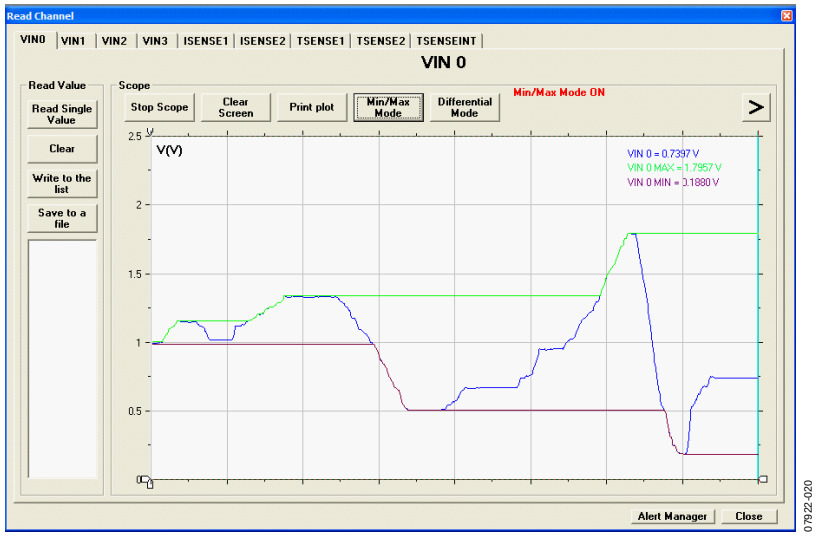

Figure 20. Minimum/Maximum Mode of Operation for the Read Channel Window

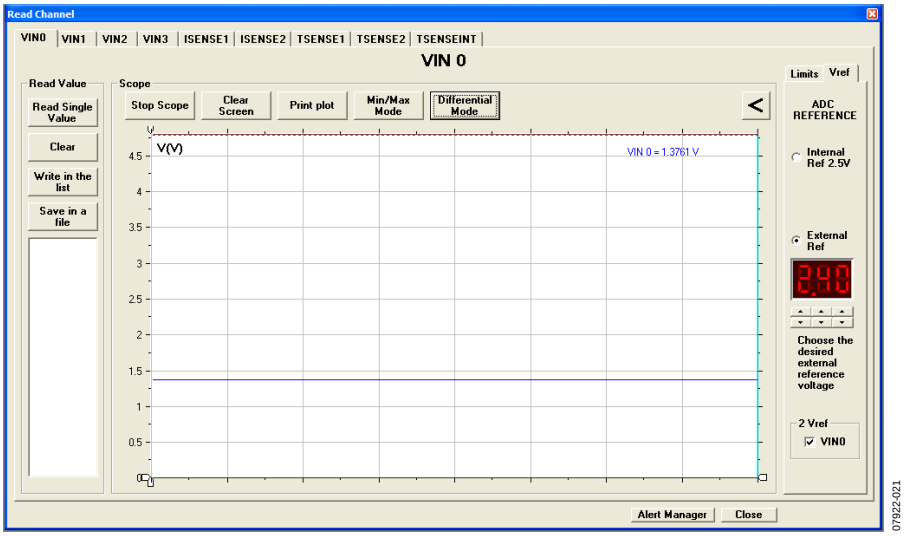

Figure 21. Vref Tab of the Read Channel Window

The current sense tabs (**ISENSE1** and **ISENSE2**) in the **Read Channel** window offer two additional advantages: you can enter a desired R_{SENSE} value—from 10 mΩ up to 999 mΩ—to be used on the evaluation board (see Figure 22), or, if a larger R_{SENSE} resistor is required, you can scale the y-axis results in proportion to the R_{SENSE} on the board. For example, if an R_{SENSE} of 1.1 Ω is required with a 10 mΩ R_{SENSE} on the board, divide the y-axis result by 110 or divide the y-axis scale by 20.

ALERT MANAGER WINDOW

The **Alert Manager** window analyzes the alert register to check for any alert events. An alert is signaled on a specific channel when the input analog signal becomes greater than or less than the specified limits. The software changes the marker from the color gray to the color red to convey an alert (see Figure 23). Due to timing constraints inherent in the software and Windows, an alert can be checked every 100 ms to 2000 ms. The period can be controlled using the scroll bar at the bottom of the window. The entire contents of the alert register can be cleared by writing all 1s to the alert status register.

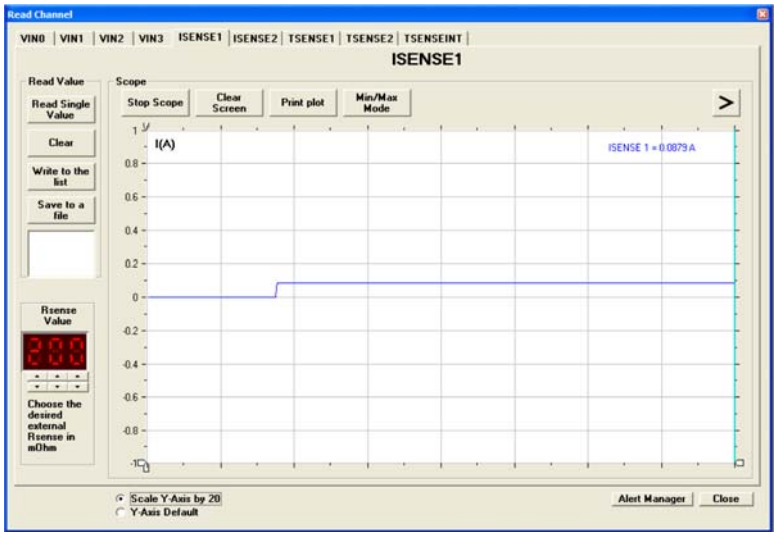

Figure 22. ISENSE1 Tab of the Read Channel Window

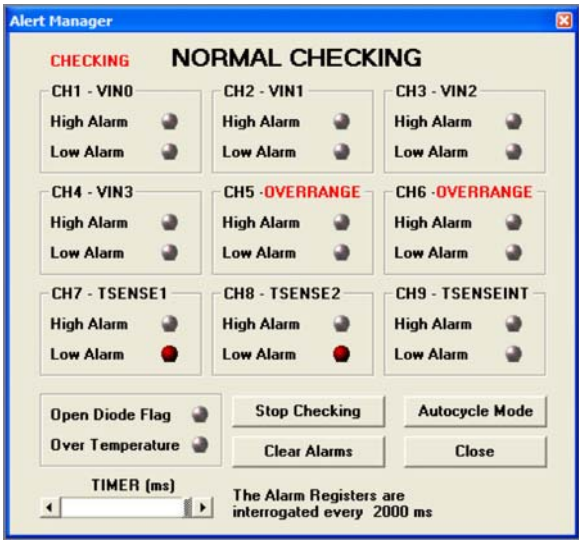

Figure 23. Alert Manager Window

The **Alert Manager** window also allows the autocycle mode to be selected for the four uncommitted analog input channels as well as the two I_{SENSE} channels. The desired channels can be selected by clicking **Autocycle Mode** in the **Alert Manager** window and then selecting the appropriate check boxes in the **Channels** box on the right side of the window (see Figure 24). Consult the **Register Map** window for the assignment of each alert bit into the three alert registers.

EXTERNAL TEMPERATURE SENSOR OFFSET CALIBRATION WINDOW

The **External Temperature Sensor Offset Calibration** window is used to calibrate the temperature, correcting errors attributable to noise that may be coupled onto the Dx+ and Dx− lines of the remote temperature sensors. Both $T_{SENSE}1$ and $T_{SENSE}2$ can be offset using the gauges shown in Figure 25. The gauges can be adjusted from between −32°C and +31.75°C, and the resulting value is automatically subtracted as a twos complement 8-bit reading from every temperature measurement before the value is stored in the relative result register.

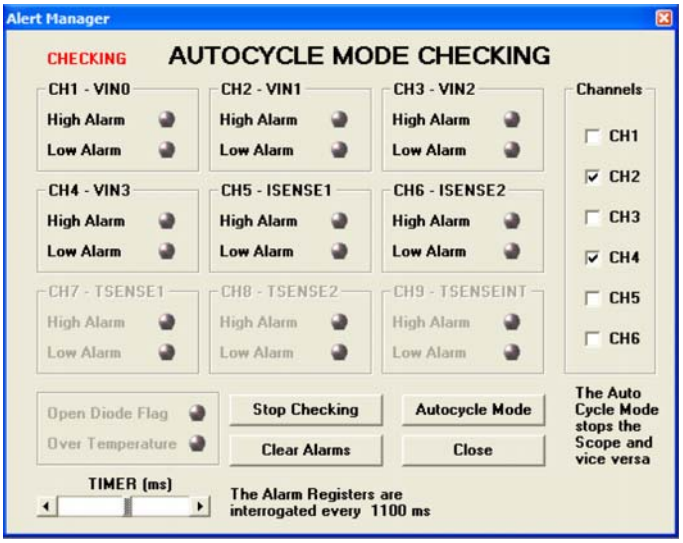

Figure 24. Autocycle Mode in the Alert Manager Window

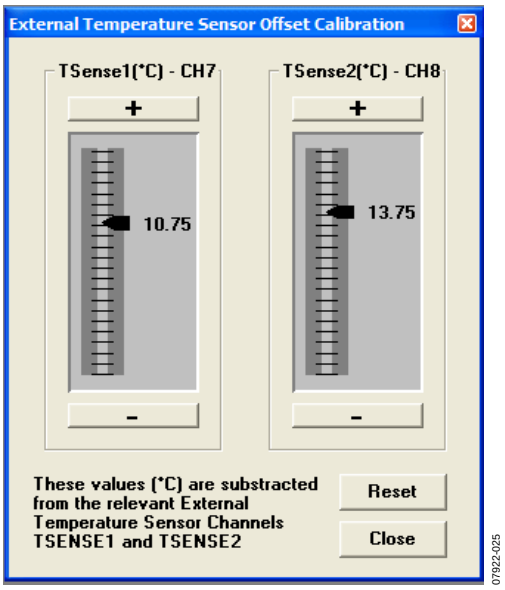

Figure 25. External Temperature Sensor Offset Calibration Window

LOAD DAC WINDOW

The **DAC** tab in the main window contains only one option, **Load DAC Channel**. The **Load DAC** window allows you to select any of the four DAC outputs and then load a value, using the gauge on the left side of the window (see Figure 26). All four DACs can be loaded simultaneously. Note that the DAC output is twice the reference voltage when no offset is applied.

An external offset can be applied to a particular DAC by clicking **External Offset** at the bottom of the **Load DAC** window. The **External Offset** box then opens on the right side of the **Load DAC** window. You can select an offset of greater than or equal to 1.67 V. The resulting DAC output shown in the **Plot** box is given by

$$V_{OUT} = 3V_{OFFSET} - 5 + V_{DAC}$$

Figure 27 shows an external voltage of 2.0 V being applied to DAC1. As a result, the DAC1 output is approximately 3.5 V, as determined by the previous formula and shown in the **Plot** box of Figure 27. Make sure to select the appropriate check box in the **External Offset** box in this window to load the offset. In addition, note that if an offset voltage is applied to the OFFSET IN x pin to achieve DAC output voltages in excess of 5 V, an external DAC_OUTPUT_V+ of up to 16.5 V is required via Terminal J3.3. For more details, refer to the AD7294 data sheet.

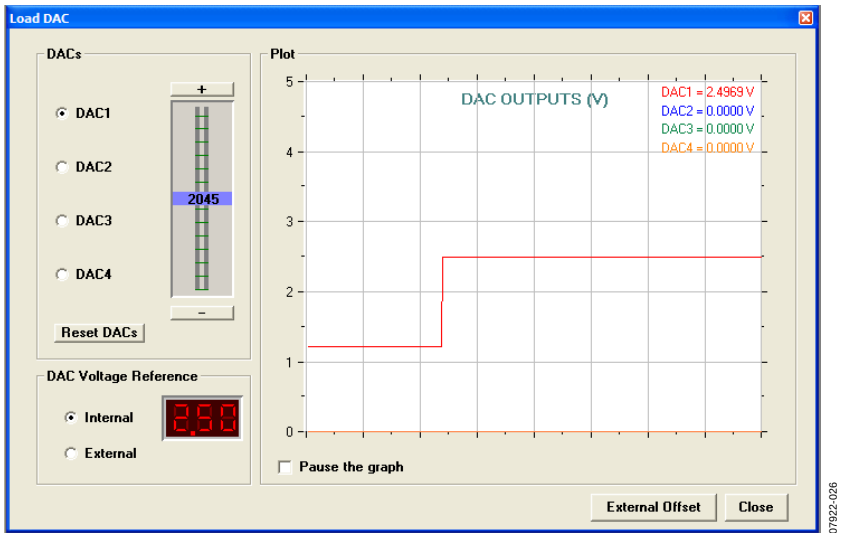

Figure 26. Load DAC Window

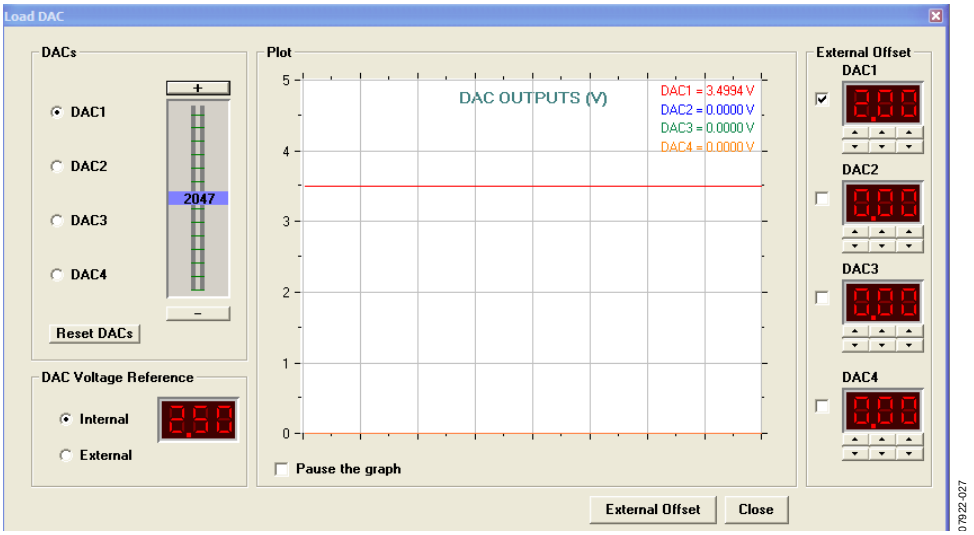

Figure 27. External Offset in Load DAC Window

FREQUENTLY ASKED QUESTIONS

How Can I Confirm that the Hardware Has Been Correctly Installed in my Computer?

Right-click **My Computer** and left-click **Properties**. On the **Hardware** tab, click **Device Manager** (see Figure 28).

Figure 28. Accessing the Device Manager

Scroll to **Universal Serial Bus controllers** and expand this root directory (see Figure 29). When the AD7294 hardware is correctly installed, each time you plug the USB cable into the evaluation board, the items under the **Universal Serial Bus controllers** root is refreshed. Figure 29 indicates that the AD7294 is present each time the evaluation board and USB cable is plugged in correctly. It is subsequently refreshed when the USB cable is unplugged from the evaluation board and the AD7294 evaluation kit connection is removed from the root.

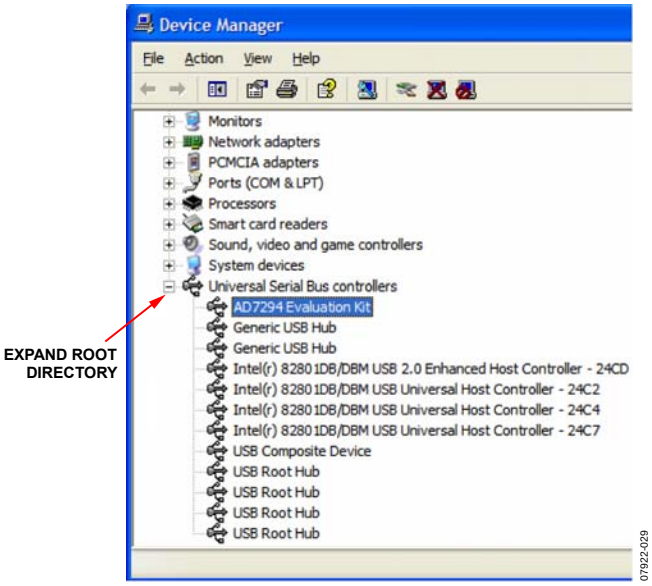

Figure 29. Universal Serial Bus Controllers Root Directory, with Correctly Installed Hardware

During the Installation, the Message in Figure 30 Appears. When I Click Finish, the Message in Figure 31 Appears. What Do I Do Next?

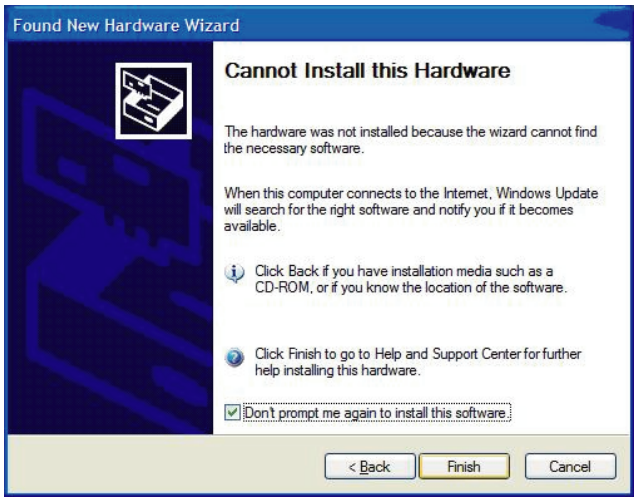

Figure 30. Cannot Install this Hardware Message

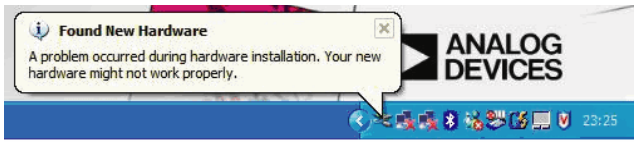

Figure 31. Hardware Installation Error Message

Assuming that the software is installed correctly, this message simply indicates that the AD7294 device drivers have not been installed to the correct folder. Therefore, the computer has not recognized the USB device (that is, the AD7294 evaluation board that is plugged in). To install the drivers, right-click **My Computer** and left-click **Properties**. On the **Hardware** tab, click **Device Manager**. Expand **Other devices** (see Figure 32), and then right-click **USB Device** and choose **Uninstall Driver**. Unplug the

evaluation board and wait for approximately 30 sec before plugging it in again.

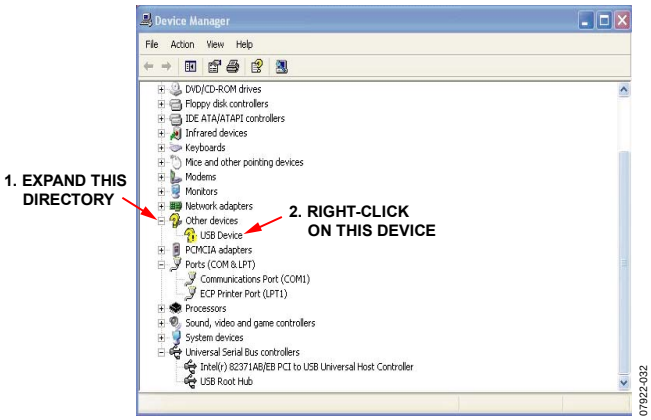

Figure 32. Uninstall the Drivers

Proceed through the installation wizard a second time. A correct installation is indicated by the expanded root directory shown in Figure 33. If you encounter the same error message the second time, uninstall the device driver and the software, and then contact the Analog Devices applications department for further instructions and driver files.

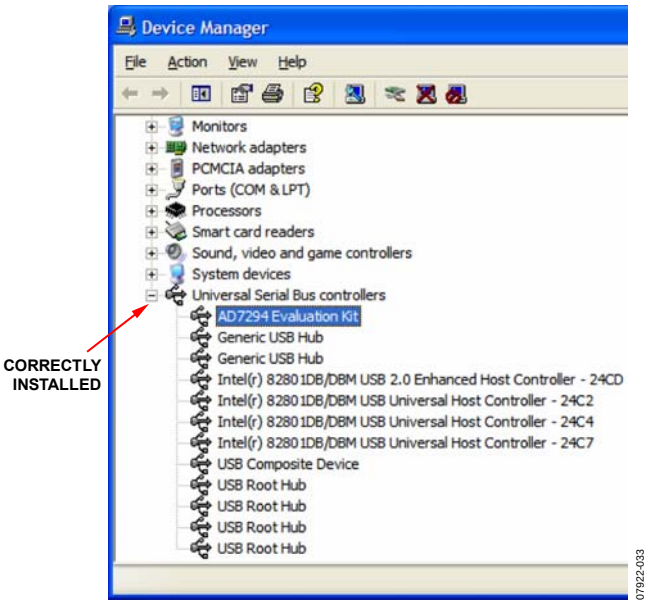

Figure 33. Correct Installation Results in an Expanded Root Directory

LAYOUT AND CONFIGURATION GUIDELINES

POWER SUPPLY DECOUPLING AND GROUNDING

When accuracy is important in a circuit, carefully consider the power supply and ground return layout on the board. The printed circuit board containing the AD7294 should have separate analog and digital sections, each having its own area of the board. If the AD7294 is in a system where other devices require an AGND-to-DGND connection, the connection should be made at one point only. This ground point should be as close as possible to the AD7294.

The power supply to the AD7294 should be decoupled with 10 μF tantalum and 0.1 μF ceramic capacitors. The capacitors should be placed as close as possible to the device, with the 0.1 μF ceramic capacitor closer to the device than the tantalum capacitor. In addition, it is important that the 0.1 μF capacitor have low effective series resistance (ESR) and low effective series inductance (ESI). The 0.1 μF capacitor provides a low impedance path to ground for high frequencies caused by transient currents due to internal logic switching.

The power supply line should have as large a trace as possible to provide a low impedance path and to reduce glitch effects on the supply line. Clocks and other components with fast-switching digital signals should be shielded from other parts of the board by a digital ground. Avoid crossover of digital and analog signals if possible. When traces cross on opposite sides of the board, ensure that they run at right angles to each other to reduce feedthrough effects on the board. The most efficient board layout technique is the microstrip technique, where the component side of the board is dedicated to the ground plane only and the signal traces are placed on the solder side; however, this is not always possible with a 2-layer board.

EVALUATION BOARD SCHEMATIC AND ARTWORK

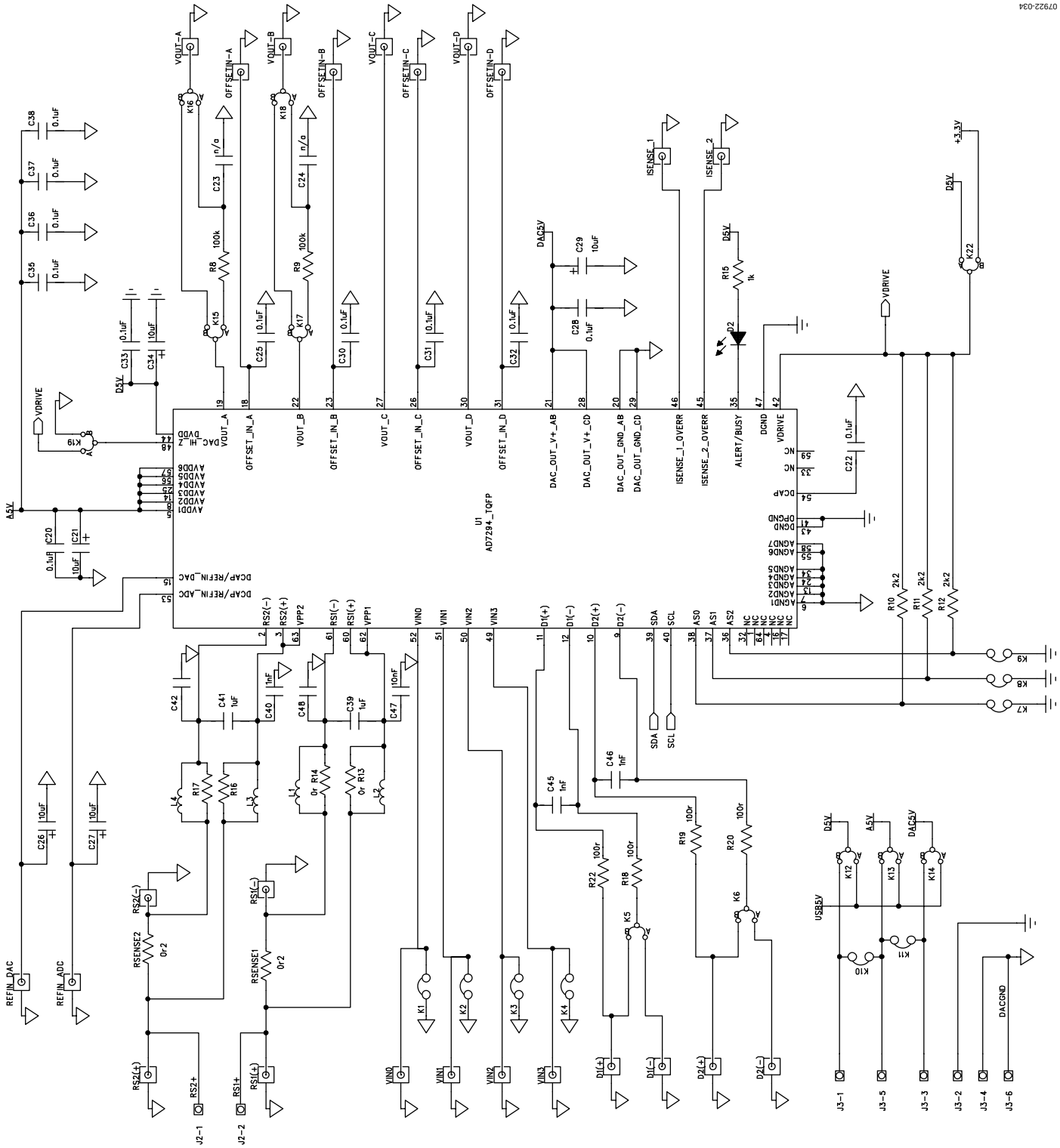

Figure 34. Evaluation Board Schematic

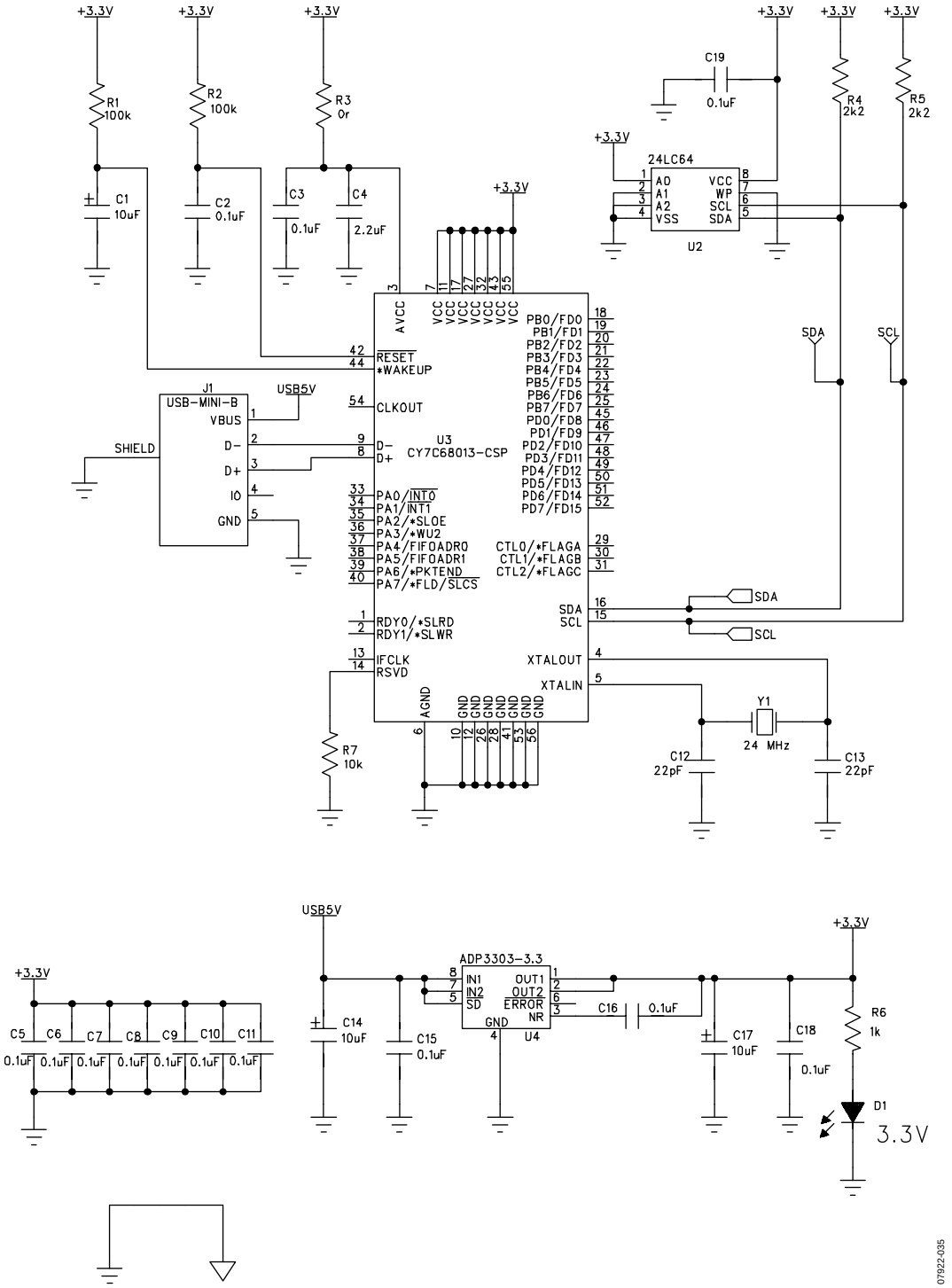

Figure 35. Evaluation Board Schematic, Auxiliary Blocks

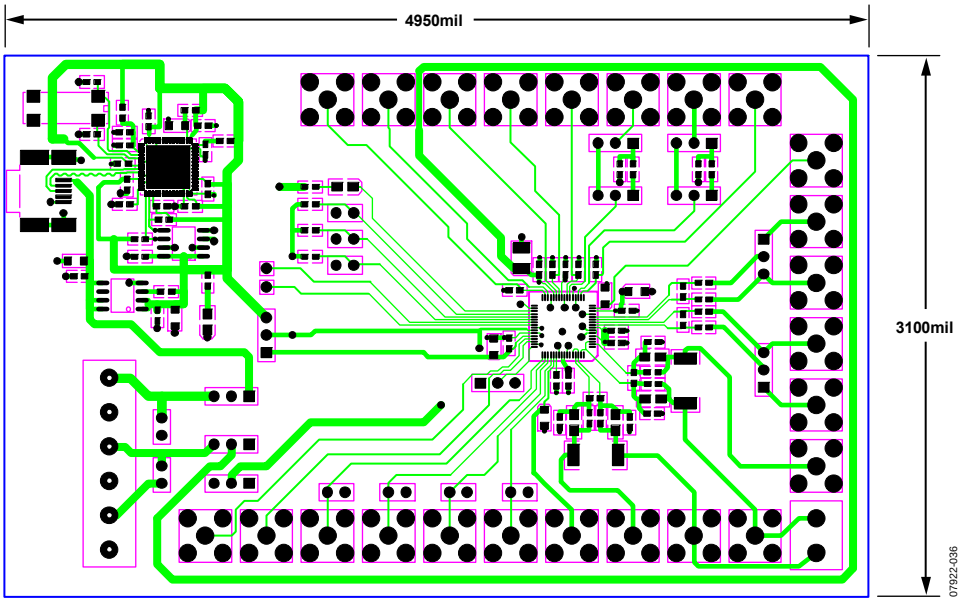

Figure 36. Evaluation Board Layout, Component Side View

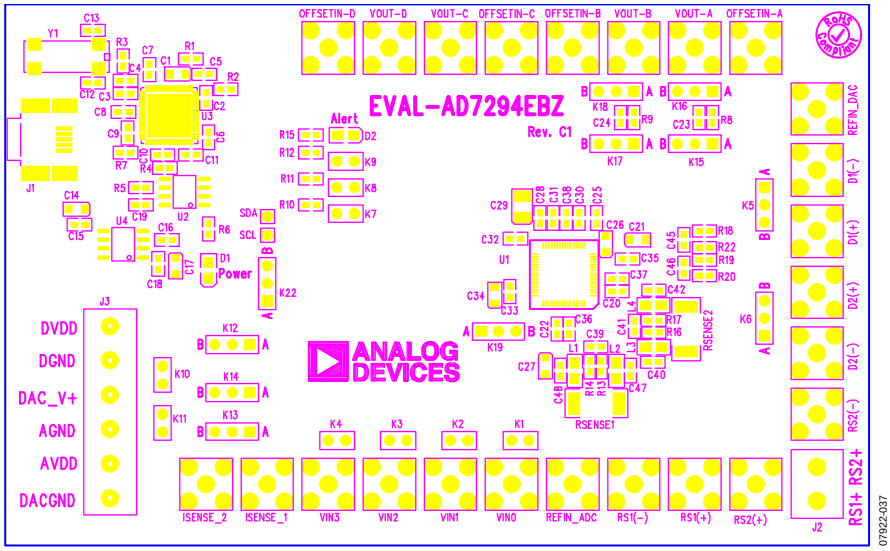

Figure 37. Evaluation Board Layout, Silkscreen View

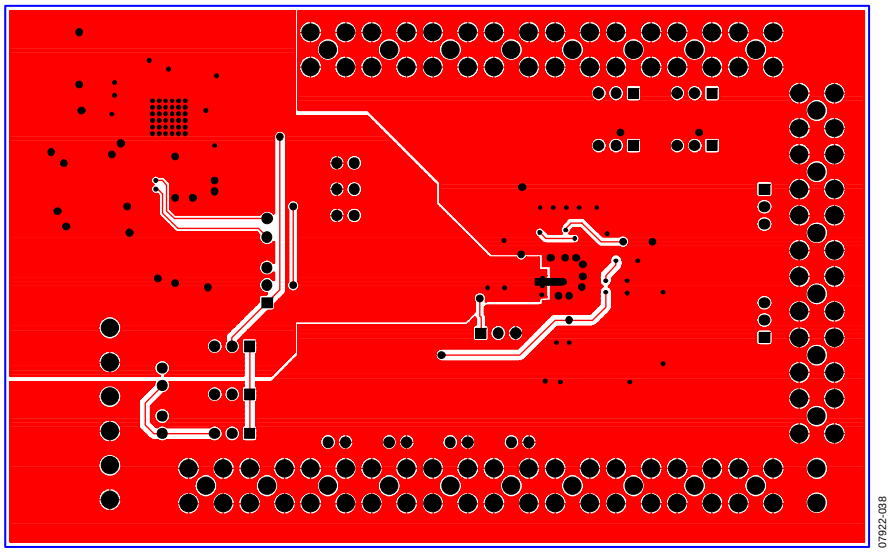

Figure 38. Evaluation Board Layout, Solder Side View

ORDERING INFORMATION

BILL OF MATERIALS

Table 5.

Qty	Reference Designator	Description	Supplier/Number[1]
24	C2, C3, C5, C6, C7, C8, C9, C10, C11, C15, C16, C18, C19, C20, C22, C25, C28, C30, C31, C32, C33, C35, C36, C37, C38	0.1 µF capacitor	FEC 136-2556
1	C47	10 nF capacitor	FEC 141-4026
3	C40, C45, C46	1 nF capacitor	FEC 141-4605
2	C39, C41	1 µF capacitor	FEC 128-8202
1	C4	2.2 µF capacitor	Digi-Key 490-1552-1-ND
2	C12, C13	22 pF capacitor	FEC 722-005
4	C23, C24, C42, C48	Not inserted	Not inserted
8	C1, C14, C17, C21, C26, C27, C29, C34	10 µF capacitor	FEC 197-130
5	R3, R13, R14, R16, R17	0 Ω resistor	FEC 933-1662
4	R1, R2, R8, R9	100 kΩ resistor	FEC 933-0402
4	R18, R19, R20, R22	100 Ω resistor	FEC 146-9862
1	R7	10 kΩ resistor	FEC 933-0399
2	R6, R15	1 kΩ resistor	FEC 933-0380
5	R4, R5, R10, R11, R12	2.2 kΩ resistor	FEC 933-0810
2	RSENSE1, RSENSE2	200 mΩ resistor	FEC 110-0068
2	D1, D2	LED	FEC 579-0852
1	U1	12-bit, multichannel, ADC, DACs, temperature sensors, and current sensors	Analog Devices AD7294BSUZ
1	Y1	24 MHz SMD quartz crystal	FEC 950-9658
1	U4	High accuracy, anyCAP®, 200 mA, low dropout linear regulator	Analog Devices ADP3303ARZ-3.3
1	U2	64k I^2C serial EEPROM	FEC 975-8070
1	U3	USB microcontroller high speed USB peripheral controller	Digi-Key 428-1669-ND
24	D1+, D1−, D2+, D2−, $I_{SENSE}1$, $I_{SENSE}2$, OFFSET IN A, OFFSET IN B, OFFSET IN C, OFFSET IN D, REF_{IN} ADC, REF_{IN} DAC, RS1(+), RS1(−), RS2(+), RS2(−), $V_{IN}0$, $V_{IN}1$, $V_{IN}2$, $V_{IN}3$, V_{OUT} A, V_{OUT} B, V_{OUT} C, V_{OUT} D	SMB connector	FEC 120-6013
1	J2	Power terminal block, connector, two pins	FEC 151-789
1	J3	Power terminal block, connector, six pins	FEC 117-7890
9	K1, K2, K3, K4, K7, K8, K9, K10, K11	Jumper 1	FEC 102-2247
11	K5, K6, K12, K13, K14, K15, K16, K17, K18, K19, K22	Jumper 2	FEC 102-2244
1	J1	USB connector	FEC 978-6490

[1] FEC = Farnell Electronics, Inc.

ORDERING GUIDE

Model	Description
EVAL-AD7294EBZ[1]	Evaluation Board for AD7294

[1] Z = RoHS Compliant Part.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.